

Claims

What is claimed is:

- 5 1. A foam cushion formed from:
- (a) at least one of rubber and a resin;
 - (b) a blowing agent;
 - (c) a polymeric adhesion modifier;
 - (d) a decomposition accelerating agent; and
 - 10 (e) a cross-linking agent;
2. The foam cushion of claim 1 wherein the rubber is synthetic rubber (SR).
3. The foam cushion of claim 2 wherein the synthetic rubber is a polybutadiene
5 rubber (BR); a polyisoprene rubber (IR); a styrene-butadiene rubber (SBR); a nitrile rubber (NBR); a butyl rubber (IIR); an ethylene-propylene terpolymer (EPDM); a silicone rubber; a neoprene rubber; a polysulfide; a polyacrylate rubber; an epichlorohydrin rubber; a fluoroelastomer (FDM); a chlorinated polyethylene (CSM); a halogenated butyl or bromobutyl (BIIR); a chlorinated polyethylene rubber (CPE); a polyurethane; a thermoplastic rubber;
20 chlorinated natural rubber, cyclized rubber; or a combination thereof.
4. The foam cushion of claim 1 wherein the rubber is natural rubber (NR).
5. The foam cushion of claim 4 wherein the natural rubber (NR) is obtained from the
25 *Hevea brasiliensis* tree, the guayule bush *Parthenoim argentatum*, the *Sapotaceae* tree, or a combination thereof.
6. The foam cushion of claim 4 wherein the natural rubber (NR) is a latex grade.
7. The foam cushion of claim 6 wherein the latex grade is ribbed smoked sheet
30 (RSS), white and pale crepes, pure blanket crepes, or a combination thereof.

8. The foam cushion of claim 4 wherein the natural rubber (NR) is a remilled grade.

9. The foam cushion of claim 8 wherein the remilled grade is estate brown crepes, estate compo crepes, thin brown crepes or remils, thick brown crepes or ambers, flat bark crepes, or a combination thereof.

10. The foam cushion of claim 4 wherein the natural rubber (NR) is technically-specified natural rubber (TSR), superior processing natural rubber (SP), technically classified natural rubber (TC), air-dried sheet natural rubber (ADS), skin natural rubber, deproteinized natural rubber (DPNR), oil-extended natural rubber (OENR), hevealplus MG natural rubber, epoxidized natural rubber, or a combination thereof.

11. The foam cushion of claim 4 wherein the natural rubber (NR) comprises cis-polyisoprene.

12. The foam cushion of claim 4 wherein the natural rubber (NR) comprises trans-polyisoprene.

13. The foam cushion of claim 4 wherein the natural rubber (NR) comprises a mixture of cis- and trans-polyisoprene.

14. The foam cushion of claim 4 wherein the natural rubber (NR) comprises about 93 wt.% to about 95 wt.% of polyisoprene.

15. The foam cushion of claim 1 wherein the rubber is employed up to about 80 wt.% of the foam cushion.

16. The foam cushion of claim 1 wherein the rubber is employed in about 5 wt.% to about 12 wt.% of the foam cushion.

17. The foam cushion of claim 1 wherein the rubber is employed in about 7 wt.% to about 9 wt.% of the foam cushion.

18. The foam cushion of claim 1 wherein the resin is a thermoplastic polymer, thermoplastic terpolymer, thermoplastic homopolymer, thermoplastic copolymer, or a combination thereof.

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19. The foam cushion of claim 18 wherein the thermoplastic copolymer comprises an ethylene vinyl acetate (EVA), an ethylene propylene rubber, an ethylene methyl acrylate copolymer, an ethylene ethyl acrylate copolymer, an ethylene(meth)acrylate polymer, a polybutylene terephthalate (PBT) polymer, or a combination thereof.

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20. The foam cushion of claim 18 wherein the thermoplastic homopolymer comprises a polyethylene, a chlorinated polyethylene, a metallocene polyethylene, a polypropylene, or a combination thereof.

21. The foam cushion of claim 18 wherein the thermoplastic terpolymer comprises a modified ethylene acrylate carbon monoxide terpolymer.

22. The foam cushion of claim 1 wherein the resin is an ethylene-vinyl acetate (EVA) copolymer.

23. The foam cushion of claim 22 wherein the ethylene-vinyl acetate (EVA) copolymer comprises about 15 wt.% to about 75 wt.% vinyl acetate.

24. The foam cushion of claim 1 wherein the resin is employed up to about 95 wt.% of the foam cushion.

25. The foam cushion of claim 1 wherein the resin is employed in about 79 wt.% to about 83 wt.% of the foam cushion.

26. The foam cushion of claim 1 wherein the resin is employed in about 80.5 wt.% to about 82.5 wt.% of the foam cushion.

27. The foam cushion of claim 1 wherein the blowing agent is a liquid at standard temperature and pressure.

5 28. The foam cushion of claim 1 wherein the blowing agent is a gas at standard temperature and pressure.

29. The foam cushion of claim 1 wherein the blowing agent is a (C₁-C₁₂)hydrocarbon, a (C₁-C₁₂)organohalogen, a (C₁-C₁₂)alcohol, a (C₁-C₁₂)ether, a (C₁-C₁₂)ester, a (C₁-C₁₂)amine, or
10 a combination thereof.

30. The foam cushion of claim 29 wherein the (C₁-C₁₂)hydrocarbon is acetylene, propane, propene, butane, butene, butadiene, isobutane, isobutylene, cyclobutane, cyclopropane, ethane, methane, ethene, pentane, pentene, cyclopentane, pentene, pentadiene, hexane, cyclohexane, hexene, hexadiene, or a combination thereof.
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31. The foam cushion of claim 1 wherein the blowing agent is ammonia, nitrogen, carbon dioxide, neon, helium, butane, isobutane, 1,1-difluoroethane, p,p'-oxybis(benzene)sulfonyl hydrazide, p-toluene sulfonyl hydrazide, p-toluene sulfonyl semicarbazide, 5-phenyltetrazole, ethyl-5-phenyltetrazole, dinitroso pentamethylenetetramine, acetone, azodicarbonamide (AC), dinitroso pentamethylene tetramine (DNPT), or a combination thereof.
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32. The foam cushion of claim 1 wherein the blowing agent is azodicarbonamide
25 (AC).

33. The foam cushion of claim 1 wherein the blowing agent is employed in about 0.1 wt.% to about 10 wt.% of the foam cushion.

30 34. The foam cushion of claim 1 wherein the blowing agent is employed in about 3 wt.% to about 4.2 wt.% of the foam cushion.

35. The foam cushion of claim 1 wherein the blowing agent is employed in about 3.5 wt.% to about 4.0 wt.% of the foam cushion.

36. The foam cushion of claim 1 wherein the polymeric adhesion modifier is an anhydride grafted polyolefin resin, a styrene maleic anhydride (SMA) copolymer, or a combination thereof.

37. The foam cushion of claim 36 wherein the anhydride is maleic anhydride.

38. The foam cushion of claim 36 wherein the polyolefin is polyethylene, polypropylene, EPDM, ethylene vinyl acetate (EVA), a copolymer thereof, or a combination thereof.

39. The foam cushion of claim 1 wherein the polymeric adhesion modifier is FUSABOND.

40. The foam cushion of claim 39 wherein the FUSABOND is FUSABOND P modified propylene, FUSABOND E modified polyethylene, FUSABOND C modified ethylene vinyl acetate, FUSABOND A modified ethylene-acrylate terpolymer, FUSABOND N modified ethylene-based rubber, or a combination thereof.

41. The foam cushion of claim 1 wherein the polymeric adhesion modifier is employed in about 0.5 wt.% to about 15.0 wt.% of the foam cushion.

42. The foam cushion of claim 1 wherein the polymeric adhesion modifier is employed in about 2.8 wt.% to about 3.9 wt.% of the foam cushion.

43. The foam cushion of claim 1 wherein the polymeric adhesion modifier is employed in about 3.0 wt.% to about 3.5 wt.% of the foam cushion.

44. The foam cushion of claim 1 wherein the cross-linking agent is a radical generating species.

45. The foam cushion of claim 1 wherein the cross-linking agent is a peroxide.

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46. The foam cushion of claim 45 wherein the peroxide is methylethylketone peroxide; dicumyl peroxide; 2,5-dimethyl-2,5-di(t-butylperoxy)hexane; 1,1-bis(t-butylperoxy)-3,3,5-trimethylcyclohexane; 1,1-di-(t-butylperoxy)cyclohexane; 2,2'-bis(t-butylperoxy)diisopropylbenzene; 4,4'-bis(t-butylperoxy)butylvalerate; Ethyl 3,3-bis(t-butylperoxy) butyrate; t-butyl cumyl peroxide; Di [(t-butylperoxy)-isopropyl] benzene; t-butyl peroxide; 6,6,9,9-tetramethyl-3-methyl-3, n-butyl-1,2,4,5-tetraoxycyclononane; 6,6,9,9-tetramethyl-3-methyl-3-ethyl arbonylmethyl 1,2,4,5-tetraoxy-cyclononane; ethyl 3,3-di (t-butylperoxy)-butyrate; dibenzoyl peroxide; 2,4-dichlorobenzoyl peroxide; OO-t-butyl O-(2-ethylhexyl) mono peroxy carbonate; t-butyl cumyl peroxide; 2,5-dimethyl-2,5-di-(t-butylperoxy)hexyne-3; or a combination thereof.

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47. The foam cushion of claim 1 wherein the cross-linking agent is dicumyl peroxide (DCP).

48. The foam cushion of claim 1 wherein the cross-linking agent is employed in about 0.1 wt.% to about 2.0 wt.% of the foam cushion.

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49. The foam cushion of claim 1 wherein the cross-linking agent is employed in about 0.5 wt.% to about 0.9 wt.% of the foam cushion.

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50. The foam cushion of claim 1 wherein the cross-linking agent is employed in about 0.6 wt.% to about 0.7 wt.% of the foam cushion.

51. The foam cushion of claim 1 wherein the cross-linking agent is triallyl cyanurate (TAC); triallyl isocyanurate (TAIC), triallyl phosphate (TAPA), ethylene glycol dimethacrylate; trimethylol propane trimethacrylate; allyl methacrylate; or a combination thereof.

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52. The foam cushion of claim 51 wherein the alkoxysilane is methyltrimethoxy silane, dimethyldimethoxy silane, vinyltrimethoxy silane, phenyltrimethoxy silane, diphenyldimethoxy silane, methyltriethoxy silane, dimethyl diethoxy silane, phenyl triethoxy silane, diphenyl diethoxy silane, or a combination thereof.

53. The foam cushion of claim 51 wherein the oximesilane is methyltris (methylethylketoxime) silane, dimethylbis (methylethylketoxime) silane, phenyltris (methylethylketoxime) silane, vinyltris (methylethylketoxime) silane, diphenylbis (methylethylketoxime) silane, or a combination thereof.

54. The foam cushion of claim 1 wherein the decomposition accelerating agent is at least one of an inorganic salt, a lead-containing compound, a metallic soap, a urea compound, and R^1COOR^2 , wherein:

R^1 is (C_1-C_{20}) alkyl, (C_2-C_{20}) alkenyl, (C_1-C_{20}) alkynyl, aryl (C_1-C_{20}) alkyl, aryl (C_2-C_{20}) alkenyl, aryl (C_2-C_{20}) alkynyl, cycloalkyl (C_1-C_{20}) alkyl, cycloalkyl (C_2-C_{20}) alkenyl, or cycloalkyl (C_2-C_{20}) alkynyl; and

R^2 is hydrogen, (C_1-C_{20}) alkyl, (C_2-C_{20}) alkenyl, (C_1-C_{20}) alkynyl, aryl (C_1-C_{20}) alkyl, aryl (C_2-C_{20}) alkenyl, aryl (C_2-C_{20}) alkynyl, cycloalkyl (C_1-C_{20}) alkyl, cycloalkyl (C_2-C_{20}) alkenyl, or cycloalkyl (C_2-C_{20}) alkynyl;

wherein any alkyl, alkenyl, alkynyl, cycloalkyl, or aryl is optionally substituted on carbon with one or more halo, nitro, cyano, (C_1-C_{20}) alkoxy, or trifluoromethyl;

or a pharmaceutically acceptable salt thereof.

55. The foam cushion of claim 1 wherein the decomposition accelerating agent is an inorganic salt.

56. The foam cushion of claim 1 wherein the decomposition accelerating agent is a carboxylic acid.

57. The foam cushion of claim 1 wherein the decomposition accelerating agent is a combination of an inorganic salt and a carboxylic acid.

58. The foam cushion of claim 1 wherein the decomposition accelerating agent is zinc oxide, tribasic lead sulfate, zinc stearate, lead stearate, CELLPASTE-K5, stearic acid, or a combination thereof.

59. The foam cushion of claim 1 wherein the decomposition accelerating agent is a combination of zinc oxide and stearic acid.

60. The foam cushion of claim 1 wherein the decomposition accelerating agent is employed up to about 25 wt.% of the foam cushion.

61. The foam cushion of claim 1 wherein the decomposition accelerating agent is employed in about 1.5 wt.% to about 13.5 wt.% of the foam cushion.

62. The foam cushion of claim 1 wherein the decomposition accelerating agent is employed in about 2.0 wt.% to about 13.0 wt.% of the foam cushion.

63. The foam cushion of claim 1 further comprising at least one of a cure retarder, a reinforcing agent, a filler, an extender, a plasticizer, a vulcanization agent, an antioxidant, a fire retardant, an accelerator, a colorant, an electrically conductive material, and a stabilizer.

64. A foam cushion formed from:

- (a) at least one of natural rubber and an ethylene-vinyl acetate (EVA) copolymer;
- (b) azodicarbonamide (AC);
- (c) FUSABOND;
- (d) dicumyl peroxide; and
- (e) a combination of zinc oxide and stearic acid.

65. A foam cushion formed from:

(a) natural rubber employed in about 5 wt.% to about 12 wt.% of the foam cushion;

(b) an ethylene-vinyl acetate (EVA) copolymer employed in about 79 wt.% to about 83 wt.% of the foam cushion;

5 (c) azodicarbonamide (AC) employed in about 3 wt.% to about 4.2 wt.% of the foam cushion;

(d) FUSABOND employed in about 2.8 wt.% to about 3.9 wt.% of the foam cushion;

10 (e) dicumyl peroxide employed in about 0.5 wt.% to about 0.9 wt.% of the foam cushion; and

(f) a combination of zinc oxide and stearic acid, wherein the zinc oxide is employed in about 1.0 wt.% to about 2.2 wt.% of the foam cushion and stearic acid is employed in about 0.5 wt.% to about 1.25 wt.% of the foam cushion.

5 66. A method for manufacturing a foam cushion, the method comprising the steps of:

(a) contacting rubber, a resin, a blowing agent, a polymeric adhesion modifier, and decomposition accelerating agent to form a first mixture;

20 (b) contacting the first mixture with a cross-linking agent to form a second mixture;

(c) spreading the second mixture to form one or more sheets; and

(d) pressing the one or more sheets at an elevated temperature and an elevated pressure to form a foam cushion.

25 67. The method of claim 66 wherein the one or more sheets have a combined thickness of up to about 12 inches.

68. The method of claim 66 wherein the one or more sheets have a combined thickness of up to about 6 inches.

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69. The method of claim 66 wherein the one or more sheets have a combined thickness of up to about 4 inches.

70. The method of claim 66 wherein the rubber, resin, blowing agent, polymeric adhesion modifier, and decomposition accelerating agent are contacted above about 80°C.

71. The method of claim 66 wherein the rubber, resin, blowing agent, polymeric adhesion modifier, and decomposition accelerating agent are contacted at about 110°C to about 130°C.

72. The method of claim 66 wherein the rubber, resin, blowing agent, polymeric adhesion modifier, and decomposition accelerating agent are contacted for more than about 1 minute.

73. The method of claim 66 wherein the rubber, resin, blowing agent, polymeric adhesion modifier, and decomposition accelerating agent are contacted for about 8 minutes to about 20 minutes.

74. The method of claim 66 wherein the first mixture and the cross-linking agent are contacted above about 80°C.

75. The method of claim 66 wherein the first mixture and the cross-linking agent are contacted at about 110°C to about 130°C.

76. The method of claim 66 wherein the first mixture and the cross-linking agent are contacted for more than about 1 minute.

77. The method of claim 66 wherein the first mixture and the cross-linking agent are contacted for about 2 minutes to about 4 minutes.

78. The method of claim 66 wherein each of the one or more sheets have a thickness of about 0.5 mm to about 20 mm.

79. The method of claim 66 wherein each of the one or more sheets have a thickness of about 1 mm to about 8 mm.

80. The method of claim 66 further comprising cooling the one or more sheets.

81. The method of claim 66 further comprising cutting the one or more sheets.

82. The method of claim 66 further comprising stacking the one or more sheets.

83. The method of claim 66 further comprising contacting the one or more sheets, prior to the pressing, with a solution that comprises a silicone-containing compound.

84. The method of claim 66 wherein the pressing of the one or more sheets is performed at above about 80°C.

85. The method of claim 66 wherein the pressing of the one or more sheets is performed at about 160°C to about 175°C.

86. The method of claim 66 wherein the pressing of the one or more sheets is performed for more than about 1 minute.

87. The method of claim 66 wherein the pressing of the one or more sheets is performed for about 28 minutes to about 35 minutes.

88. The method of claim 66 further comprising removing a portion of the top of the one or more sheets and removing a portion of the bottom of the one or more sheets.

89. The method of claim 66 further comprising attaching, end-to-end, two or more of the foam cushions.

90. The method of claim 89 wherein the attachment is performed with a laser, a hot knife machine, adhesive, cauterization, or a combination thereof.

91. The method of claim 66 further comprising rinsing the foam cushion with water.

92. The method of claim 66 further comprising scrubbing the foam cushion.

93. The method of claim 91 or 92 further comprising drying the foam cushion.

94. A method for manufacturing a foam cushion, the method comprising the steps of:
(a) contacting rubber, a resin, a blowing agent, a polymeric adhesion modifier, and a decomposition accelerating agent to form a first mixture;
(b) contacting the first mixture with a cross-linking agent to form a second mixture;
(c) heating the second mixture;
(d) spreading the second mixture to form a sheet;
(e) cooling the sheet;
(f) stacking a plurality of the sheets;
(g) pressing the plurality of the sheets to form a cooked stack; and
(h) slicing the cooked stack into sliced pieces to provide the foam cushion.

95. A method for manufacturing a foam cushion, the method comprising the steps of:
(a) contacting rubber, a resin, a blowing agent, a polymeric adhesion modifier, and a decomposition accelerating agent for about 8 minutes to about 20 minutes at about 110°C to about 130°C to form a first mixture;

(b) contacting the first mixture with a cross-linking agent for about 1 minute to about 5 minutes at about 110°C to about 130°C to form a second mixture;

(c) heating the second mixture at about 100°C to about 120°C until the second mixture becomes concentrated to about 20 mm thickness;

(d) spreading the second mixture to form a sheet;

(e) cooling the sheet to below about 80°C;

(f) stacking a plurality of the sheets;

(g) contacting the plurality of sheets with a solution comprising a silicone-containing compound;

(h) pressing the plurality of the sheets for about 28 minutes to about 35 minutes at about 160°C to about 175°C to form a cooked stack;

(i) cutting, horizontally, a portion of the top of the cooked stack and removing that portion;

(j) cutting, horizontally, a portion of the bottom of the cooked stack and removing that portion;

(k) slicing the cooked stack into sliced pieces having a thickness of about 1 mm to about 20 mm;

(l) attaching two or more of the sliced pieces on an end-to-end basis; and

(m) rinsing, scrub washing, and drying the attached sliced pieces to provide the foam cushion.

96. A foam cushion formed from the method recited in any one of claims 66, 94, and 95.

97. The use of a foam cushion as recited in any one of claims 1, 64, and 65 for medical devices, footwear, orthopedic footwear, orthopedic inserts for footwear, upholstery padding for land vehicles, upholstery padding for air vehicles, upholstery padding for water vehicles, back and buttock cushions for use in wheelchairs, back and buttock cushions for use in scooters, back and buttock cushions for use in power chairs, insulation products, acoustical resistant products, thermal resistant products, electrical resistant products, electrical conductive products, vibrational resistant products, floor mat, exercise floor mat, seat padding, wall padding, padding for impact protection, flooring, flooring underlayments, siding, fencing, mattress pads, pillows, cushioning for furniture, cushioning for seat cushions, carpet underpadding, roofing,

